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FERTILIZERS FOR COTTON SOILS

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FERTILIZERS FOR COTTON SOILS

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FERTILIZERS USED IN THE COTTON BELT

In the production of cotton from 40,000,000 to 50,000,000 acres of land and approximately 2,000,000 tons of commercial fertilizers are utilized annually in the United States. In 1930 cotton was planted on 46,191,000 acres of land and 2,403,288 tons of commercial fertilizers were used in growing the crop.

In four States of the southeastern Cotton Belt—North Carolina, South Carolina, Georgia, and Alabama—1,646,420 tons of commercial fertilizers were used, amounting to 69 per cent of all the fertilizers used on this crop in the United States. In Table 1 the 1930 statistics are given, showing the acreage planted to cotton, acre yields, and amounts of fertilizers used in growing cotton in all the Southern States.

Fertilizers have long been recognized as an especially important factor in cotton production in the Southeastern States. In this belt the amount of cotton land fertilized ranged in different States from 91.4 to 97 per cent of the acreage in cotton in 1930. The average quantity used per acre varied from 262 pounds in Alabama to 425 pounds in North Carolina. The average acre yield of lint cotton in the several States of the southeastern group ranged from 188 pounds in Alabama to 233 pounds in North Carolina.

From 43.9 to 58 per cent of the acreage planted to cotton in the various States of the South Central group, excepting Missouri, was fertilized. The average rate of fertilizer used per acre in this region is comparatively low. In the Southwestern States only a small amount of fertilizer is used in growing cotton, and this is confined to a relatively small acreage.

Table 1.—*Percentage of cotton acreage fertilized, amount of fertilizer used per acre, and average yield of cotton per acre, in 1930,*[1] *by States*

	Acreage fertilized	Average amount of fertilizer per acre used	Average yield of lint cotton per acre	Number of acres in cotton	Short tons of commercial fertilizer used
	Per cent	*Pounds*	*Pounds*	*Acres*	*Tons*
Southeastern States:					
Virginia	95.5	408	228	90,000	17,544
North Carolina	97.0	425	233	1,644,000	338,938
South Carolina	90.9	330	227	2,211,000	331,980
Georgia	95.9	272	190	3,946,000	515,168
Alabama	91.9	262	188	3,820,000	460,334
Florida	91.4	248	[2] 232	105,000	11,904
South Central States:					
Mississippi	58.0	220	169	4,296,000	274,120
Louisiana	52.0	180	162	2,125,000	90,450
Arkansas	43.9	185	112	3,985,000	162,152
Tennessee	54.4	218	156	1,252,000	75,101
Missouri	6.9	145	207	377,000	1,885
Southwestern States:					
Texas	7.0	175	108	17,536,000	107,450
Oklahoma	1.9	175	106	4,165,000	7,262
Arizona			324	212,000	
New Mexico			333	134,000	
California			402	273,000	

[1] From U. S. Dept. Agr. Yearbook, 1931.

[2] 10-year average 1919–1928 was 106 pounds per acre.

ANALYSES OF FERTILIZERS SUITABLE FOR COTTON SOILS

The composition of fertilizers best suited for the growing of cotton varies with soil and climatic conditions. In the Southeastern States most soils used for cotton growing require for normal growth and development, including abundant boll formation and early maturity, a complete fertilizer containing a well-balanced proportion of nitrogen, phosphoric acid, and potash, the analyses and fertilizer material depending, in large measure, on the type of soil.

Nitrogen is probably the most important fertilizer constituent in the growing of cotton on most soils. It is required for vigorous growth in the early part of the season. . A lack of nitrogen is evidenced by a small and slow growth and a light-colored and pale-green vegetation. Excessive quantities of nitrogen cause the plant to produce excessive vegetation, to continue growth late in the season, and to mature its cotton late. Phosphorus is essential for the plant at all stages of growth, but its principal and most important rôle is in the maturing of the cotton. Field experiments on a large number of soil types have shown that phosphorus hastens the maturing and opening of the bolls. Potash is essential for the normal development of the cotton plant and for the proper maturing and opening of the bolls. On the title-page is shown a field of cotton fertilized with a well-balanced mixture.

The United States Department of Agriculture and the experiment stations in the Southern States have conducted numerous field experiments on a large number of soil types to determine the proper fertilizer analyses for cotton, and from a digest of these results the following conclusions may be drawn:

On the gray sandy loam soils of the coastal plains occurring in the extreme northeastern section of the Cotton Belt, including southeastern Virginia and northeastern North Carolina, which normally produce a rank vegetative growth, making early maturity an essential factor, a mixture containing 4 per cent nitrogen, 12 per cent phosphoric acid, and 4 to 6 per cent potash is suitable. On the lighter soil types in this region, on which vegetative growth is inclined to be less vigorous, a mixture containing 6 per cent nitrogen, 10 per cent phosphoric acid, and 4 to 6 per cent potash may give the best results.

For the heavy clay loam and sandy loam soils of the central coastal-plain section, including eastern North Carolina and eastern South Carolina, which normally produce rank vegetative growth, making early maturity an essential factor, a mixture containing 4 per cent nitrogen, 10 per cent phosphoric acid, and 4 per cent potash is suitable. On the lighter sandy and sandy loam soils of the region, in order to stimulate vegetative growth, a mixture containing 4 to 5 per cent nitrogen, 8 per cent phosphoric acid, and 3 to 4 per cent potash may be used with better results. On the lighter sandy soils of this region the use of from 18 to 30 pounds of nitrogen per acre from materials containing nitrogen in readily available form has proved profitable when applied after the cotton is up. Figure 1 shows the effect of fertilizers on growth of cotton in the early spring, and Figure 2 the effect of nitrogen and phosphates on yield and time of maturity of cotton.

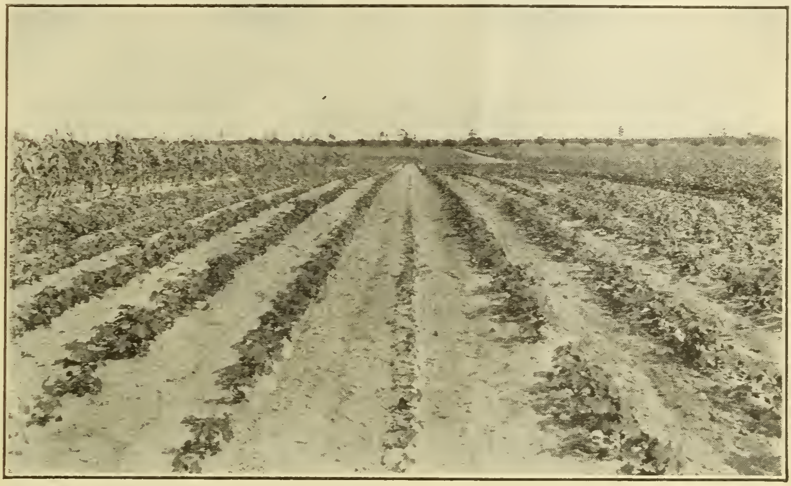

FIGURE 1.—Effect of commercial fertilizers on growth of cotton in the early season on Orangeburg sandy loam in South Carolina. Center row, no fertilizer; left and right sections of fields received 800 pounds of a fertilizer analyzing 4 per cent nitrogen, 8 per cent phosphoric acid, and 4 per cent potash, applied to side of seed before planting

For the clays and clay loams of the piedmont section of North Carolina, South Carolina, Georgia, and Alabama a mixture containing 4 to 5 per cent nitrogen, 10 per cent phosphoric acid, and 2 to 3 per cent potash has given good results. The sandier soils of this region may do better with mixtures containing 4 to 5 per cent potash. On the less fertile soils of this region it is considered a good practice to use from 18 to 30 pounds of nitrogen per acre, from readily available materials, after the cotton is up.

On the coastal-plain soils of Georgia, particularly the heavy, dark, pebbly soils of the Tifton series, a mixture containing 3 per cent nitrogen, 9 per cent phosphoric acid, and 5 per cent potash is recommended. A mixture containing 3 per cent nitrogen, 9 per cent phosphoric acid, and 8 per cent potash may be better for the sandier and lighter phase of this soil. The gravelly sandy soils of the Norfolk series respond well to a mixture containing 4 per cent nitrogen, 8 per cent phosphoric acid, and 4 per cent potash; and for the red and brown soils of the Greenville and Orangeburg series a mixture containing 4 per cent nitrogen, 10 per cent phosphoric acid, and 4 per cent potash seems most effective. On the light, porous sandy soils of this region from 18 to 20 pounds of readily available nitrogen per acre can be used at the first cultivation of cotton after chopping in addition to the usual application of complete fertilizer before planting.

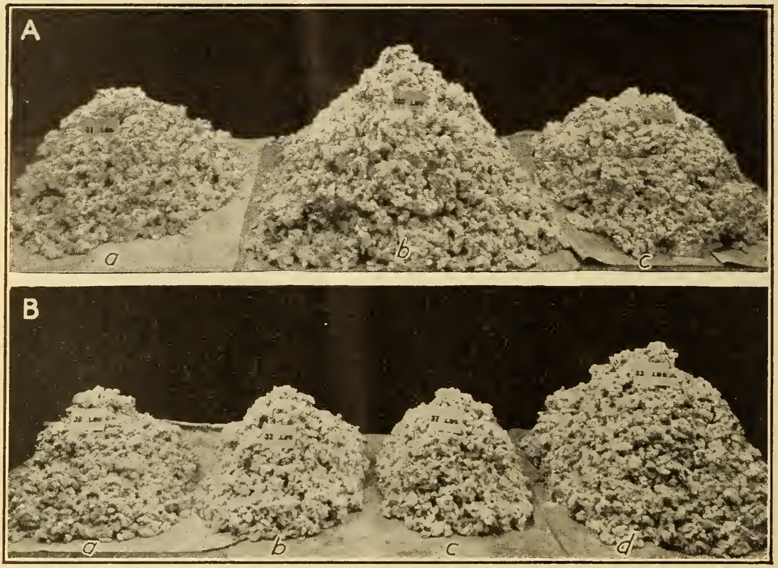

FIGURE 2.—A, Effect of fertilizers with and without nitrogen on yield of cotton on Norfolk sandy loam. Yield from one-twentieth acre: *a*, No fertilizer, yield 31 pounds, equivalent to 620 pounds per acre; *b*, 800 pounds of fertilizer containing phosphate, potash, and 6 per cent nitrogen, yield 100 pounds, equivalent to 2,000 pounds per acre; *c*, 800 pounds of fertilizer containing phosphate, potash, and no nitrogen, yield 49 pounds, equivalent to 980 pounds per acre. B, Effect of phosphate and nitrogen on yield and time of maturing of cotton on Norfolk sandy loam. Yield from one-twentieth acre: *a*, Yield at first picking from plot fertilized with superphosphate, 30 pounds, equivalent to 600 pounds per acre; *b*, total yield from plot fertilized with superphosphate, 32 pounds, equivalent to 640 pounds per acre; *c*, yield at first picking from plot fertilized with nitrogen, 37 pounds, equivalent to 740 pounds per acre; *d*, total yield from plot fertilized with nitrogen, 83 pounds, equivalent to 1,600 pounds per acre

For the hill and flatwoods soils of Mississippi a fertilizer containing 4 to 6 per cent nitrogen, 8 per cent phosphoric acid, and 4 per cent potash is suitable; for the prairie section the mixture may contain 8 per cent nitrogen and 8 per cent phosphoric acid, except on soils subject to cotton rust, where an 8–8–4 mixture is recommended. Where it is desired to use a higher analysis fertilizer, multiples of the foregoing ratios should be used.

For the Mississippi Delta and other bottom soils near streams in the central Cotton Belt from 25 to 30 pounds per acre of nitrogen alone has generally been used with success, and on the soils subject to cotton rust 25 pounds per acre of potash in addition to the nitrogen may be profitable.

The fertilizer requirements of the soils used for cotton in western Louisiana and eastern Texas are somewhat similar to those of the more eastern soils of the central Cotton Belt. Little fertilizer is used in the southwestern Cotton Belt which may be designated as that region having its eastern edge at the dividing line between the great black-prairie region and the timbered section of the east. It includes three-fourths of the States of Texas and Oklahoma, and all of New Mexico and Arizona. The soils of most of the region were, until recently, virgin soils still in a high state of fertility, and experiments up to the present time have not shown that under present conditions general use of fertilizers is warranted, except where the soil has been depleted by erosion.

In the black-prairie region response from applications of quickly available phosphatic fertilizers or mixtures of phosphate and quickly available nitrogen has been noted in recent cooperative experiments conducted by the department. This response is shown primarily in the rapid growth produced, early fruiting of the plant, and maturing of the cotton, resulting in a considerable increase in yield at the earlier pickings. The effect of fertilizer on early opening and maturing of cotton in this belt is shown in Figure 3.

COMPOSITION OF FERTILIZERS FOR COTTON SOILS

In preparing a fertilizer mixture for cotton, consideration should be given to the materials used.

PHOSPHATES

Superphosphate is the principal source of phosphoric acid in commercial fertilizers. Several grades are available; the lowest contains about 16 per cent phosphoric acid. Superphosphates containing from 18 to 20 per cent phosphoric acid, and a triple strength grade containing upward of 45 per cent phosphoric acid, are also manufactured. The latter may be used in preparing concentrated fertilizers, which are used to some extent in fertilizing cotton. Ammonium phosphate, produced by combining air-derived nitrogen and phosphoric acid, is one of the most important salts produced by nitrogen-fixation processes. It contains both nitrogen and phosphoric acid and is the principal source of phosphoric acid in concentrated fertilizers.

POTASH

The principal sources of potash in fertilizer used for cotton are muriate of potash, sulphate of potash, manure salts, and kainit. The first two are high-grade potash salts and contain approximately 50 per cent potash. Manure salts consist of potash salts, chiefly chloride, containing from 20 to 30 per cent potash. Kainit contains from 12 to 16 per cent potash combined with other salts.

When used in equivalent amounts there is not a wide variation in the effect of these potash salts. In a large number of experiments in the coastal plain of the southeastern Cotton Belt the muriate of potash as the source of potash in complete fertilizer gave an average yield of 1,212 pounds of seed cotton per acre, the sulphate of potash gave an average yield of 1,231 pounds, and kainit an average yield of 1,133 pounds. On piedmont soils the average yield from a large number of experiments was 938 pounds per acre from the muriate of potash, 937 pounds from sulphate of potash, and 892 pounds from kainit. The muriate of potash as a source of potash in mixed fertilizers for cotton has proved as good a source of potash as sulphate of potash according to the data secured in experiments on many soil types in the coastal plain and the piedmont sections of the southeast. Results from kainit have not been so favorable as from the muriate and sulphate of potash.

NITROGEN SOURCES

A number of nitrogen materials are used in fertilizing cotton. Sodium nitrate and ammonium sulphate are the principal inorganic sources. Both are used in mixed fertilizers and may be used alone as a side dressing after the cotton is up. Many organic materials of animal and vegetable origin are used, such as cottonseed meal, fish scrap, dried blood, tankage, sewage sludge, cocoa-shell meal, and peanut-shell meal. These are more slowly available and are not suitable as the sole source of nitrogen in fertilizers for cotton. This class of materials is used extensively for livestock feed, and for this reason commands a higher price as fertilizer than do synthetic nitrogen and nitrogen from inorganic sources. These fertilizers do not supply sufficient quickly available nitrogen in early spring, when the young cotton plants need stimulation, but supply it late in the season. If all the nitrogen in the commercial fertilizers was from such slowly available materials, delayed fruiting and maturing of the cotton might result. Nitrogen from organic sources may be used to advantage in fertilizers with inorganic and synthetic salts. Experiments with many soil types in the Cotton Belt show that better

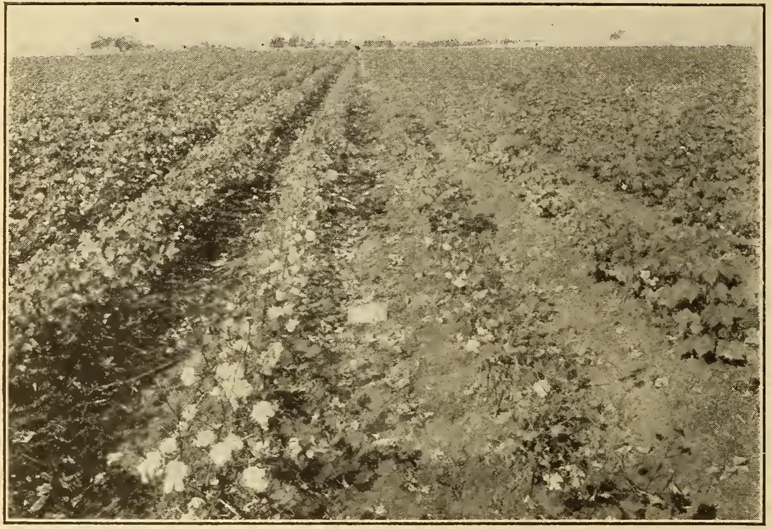

FIGURE 3.—Effect of fertilizers on growth and early maturing of cotton on Houston black clay, showing cotton opening by August 18. Left, field fertilized with phosphate and nitrogen; right, no fertilizer applied

results are obtained from fertilizers containing nitrogen derived in part from inorganic sources and in part from organic sources than from fertilizers in which all the nitrogen is from an inorganic source. In a number of experiments on various soil types the results indicate that the best proportion is from 80 to 85 per cent of nitrogen from inorganic or synthetic sources and from 15 to 20 per cent of nitrogen from organic materials derived from animal waste or of vegetable origin.

Nitrogen salts made by air-fixation processes are now also used in mixed fertilizers for cotton or may be applied separately as a side dressing after the cotton is up. In addition to synthetic sodium nitrate and ammonium sulphate, other synthetic salts in common use are urea, ammonium phosphate, calcium nitrate, and combinations of some of these with ammonium nitrate and calcium carbonate. A number of air-derived fertilizers are marketed under various trade names. Most of these contain high percentages of nitrogen, and mixtures are available containing high percentages of the three plant foods—nitrogen, phosphoric acid, and potash. Nitrogen fertilizers made by air-fixation processes, when used in mixtures with superphosphate and potash, affect cotton somewhat similarly to sodium nitrate and ammonium sulphate. In a number of experiments made on the principal soil types of the Southeastern States the yields from air-derived salts compared favorably with sodium nitrate and ammonium sulphate on many soils, but generally the yields were slightly less. Anhydrous ammonia or a concentrated ammonia liquid is combined by fertilizer manufacturers with phosphoric acid in superphosphate. This process is comparatively new, and it is claimed that its adoption will lower the cost of fertilizers to growers. The final product produced by the process is somewhat similar to mixtures of superphosphate and ammonium sulphate and should give good results.

CONCENTRATED FERTILIZERS

The manufacture of fertilizer materials of high plant-food content has made it possible to prepare mixtures containing high concentrations of nitrogen, phosphoric acid, and potash. Concentrated fertilizers are used to a limited extent in the growing of cotton and have generally given good results, but certain precautions should be taken in their application. When the fertilizers are well mixed with the soil and not placed in contact with, or too close to the seed, they should give as good results as ordinary-strength fertilizers, except possibly on light sandy soils subject to excessive leaching. The use of concentrated fertilizers in the growing of cotton is new, and experimental work in communities should precede their general use.

RATE OF FERTILIZER APPLICATION

The most profitable quantity of fertilizer to use per acre in the growing of cotton varies with soil conditions, farm management, and economic conditions. The largest average acreage applications of commercial fertilizers are in the Southeastern States. These ranged from 425 pounds in North Carolina to 262 pounds in Alabama, in 1930. In the South Central States the average acreage application ranged from 220 pounds in Mississippi to 145 pounds in Missouri, in 1930.

Many experiments with various amounts of fertilizers have been made by the State experiment stations and by the United States Department of Agriculture. Experiments[1] made on soils east of the Mississippi River show that from 600 to 800 pounds of commercial fertilizer per acre have generally proved the most profitable. There are certain soil types in the southeastern Cotton Belt, notably the soils of the black belt of Alabama, the overflow heavy silty soils of stream bottoms, and other unusual soil formations that do not generally respond to applications of commercial fertilizer. On many of these soils the growth of cotton is stimulated and the formation of cotton bolls hastened by application of 18 or 20 pounds of quickly available nitrogen before planting or shortly after the cotton is up.

In the section of the Cotton Belt west of the Mississippi River, where commercial fertilizers have proved profitable, applications are generally smaller than in the southeastern Cotton Belt. From 300 to 500 pounds of commercial fertilizer per acre have generally given as good results as large quantities.

DELAYED FERTILIZER APPLICATIONS

Fertilizers are applied to some soils after the cotton has germinated and come up. Such delayed applications are usually made in addition to the application made before planting. Occasionally a late application of mixed fertilizer, containing all three fertilizer elements—nitrogen, phosphoric acid, and potash—is used, but the late application generally consists of quickly available nitrogen materials, such as sodium nitrate and ammonium sulphate. Quickly available nitrogen applied at the first cultivation of cotton after it is chopped gives the young plant an early start and produces a rapid growth early in the season, causing it to blossom and form bolls earlier. The use of quickly available nitrogen after cotton is up is most general on sandy soils of the southeastern Cotton Belt and on heavy silt soils of stream bottoms, where growth is slow.

In the southeastern Cotton Belt the nitrogen applied late is in addition to the application of complete fertilizers made before planting, but the soils here generally require all three fertilizer elements—nitrogen, phosphate, and potash—for successful cotton yields. On the stream-bottom soils, which are generally well supplied with nutrients, nitrogen only is needed to stimulate early growth and fruiting.

For best results the quantity of nitrogen used per acre in delayed applications varies with soil conditions. Usually from 18 to 30 pounds is enough. This quantity is equivalent to approximately 100 to 167 pounds of sodium nitrate. Only quickly available nitrogen fertilizers, such as sodium nitrate, ammonium sulphate, calcium nitrate and other air-derived nitrogen, should be used for delayed applications. Slow-acting organic nitrogen materials, such as cottonseed meal, dried blood, fish scrap, tankage, and sludge, are not suitable, and as already stated the nitrogen from these sources acts slowly and results in late fruiting and maturing of the cotton.

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[1] Buie, T. S., and Warner, J. D COTTON FERTILIZER EXPERIMENTS. S. C. Agr. Expt. Sta. Bul. 245, 32 p., illus. 1928.

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FERTILIZER PLACEMENT

Cottonseed should not be planted in contact with fertilizers. Fertilizers are generally placed in a band 2 or 3 inches below the seed. It is common practice in a large section of the Cotton Belt to apply the fertilizer in an open furrow, mix it with the soil, cover with several inches of soil and allow the seed bed to settle for 8 or 10 days prior to planting the cottonseed. The settled bed is usually dragged immediately before planting. Under this procedure the seed is planted above the fertilizers. This is a safe practice and generally results in good stands.

Combination planters and fertilizer distributors, which apply the fertilizers and plant the seed simultaneously, have recently been introduced. Machines of different designs place the fertilizers in various positions in relation to the seed. The location of the fertilizer with respect to the seed is often responsible for many failures to obtain satisfactory stands of cotton. The location of and distance between seed and fertilizer for best results will vary with soil texture, moisture content of soil, and climatic conditions. Seed injury from fertilizers may result more frequently on light sandy soil than on the heavier types, and it is more severe in times of least rainfall.

The most rapid growth of young cotton plants may generally be attained with the fertilizers placed closest to the seed, provided injury to germination is not serious. On light sandy soils application of fertilizers in a band to the side of the seed seems the safest and best location. Fertilizers placed to the side of the seed row have given best results on sandy soils in extensive experiments conducted by the department. On clay and clay loam soils fertilizers applied in narrow bands 2 or 3 inches under the seed have given good results, and the seed is reasonably safe from fertilizer injury.

Cottonseed is more subject to injury from quickly soluble and concentrated fertilizers than from slowly soluble fertilizers. Precaution should be taken in applying concentrated mixtures. If such fertilizer is applied 8 or 10 days before planting the seed, mixed in the soil, and care taken not to place the seed in contact with it, good results may be expected.

Fertilizers applied after the cotton is up may be placed to the side of and a few inches from the plants. The late applications are generally quickly soluble nitrogen salts, and caution should be taken not to put the fertilizer on or too close to the young plants as injury may occur. The added material should be covered or worked into the surface soil. The placement of fertilizers in relation to the seed is an important factor in cotton growing, especially with concentrated fertilizers composed of quickly soluble salts.

In the growing of cotton serious consideration should be given to the selection of the land used and its fertilization. High acreage yields tend to lower the cost of cotton production, and the use of proper fertilizers should be helpful.

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